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The Vegetation and Environment of a Multi-Aged Eucalypt Forest near Kinglake West, Victoria, Australia

By A. M. Gill* and D. H. Ashton†

SUMMARY: A dry sclerophyll forest dominated by *Eucalyptus obliqua* and *E. radiata* (and to a lesser extent, *E. cypellocarpa*) occurs on a mosaic of red and grey soils on the Kinglake Plateau. The red soils are better structured and have slightly higher nutrient status than the grey. The vegetation on both soils is similar on similar topography although differences in species presence and cover occur. The differences may be attributed to a slightly faster rate of succession after fire on the red soil. The range of form and size of the canopy eucalypts suggests diverse ages. Beneath these a definite stratum of suppressed trees occurs, largely composed of *E. radiata*. It is possible that the absence of fire over a long period may favour *E. radiata* predominance and conversely that fire may restore the importance of *E. obliqua* in the stand. The understorey on the red soil has developed a self-perpetuating pattern of *Pultenaea muelleri* clumps together with *Pteridium* (bracken) and *Tetrarrhena juncea* (wiregrass) forty years after firing. Invasion of mature stands by broad-leaved shrubs in the absence of fire could result in a transitional wet sclerophyll forest.

INTRODUCTION AND SITE DESCRIPTION

Descriptive accounts of the structure and composition of Australian vegetation are rare, yet description yields valuable data on classification, community history, regeneration, and species relationships. This paper attempts a description of a little-disturbed eucalypt forest and its environment.

The area is approximately 40 miles NNE. of Melbourne on the Great Dividing Range at the western edge of the Kinglake Plateau. It extends for one half mile on the southern edge of the Plateau from the Cascades water channel towards Kinglake West.

The climate of this region is warm and relatively wet in summer, and cool and wet in winter. The average precipitation is likely to be similar to that recorded at two nearby weather stations: average approximately 48 inches at Wallaby Creek and 49 inches at Kinglake (Watt 1937). Precipitation falls largely as rain and contributions from snow and fog are very small. Rainfall is fairly evenly distributed throughout the year with a slight winter maximum (Table 1a). Contributions from snow and fog are very small at this altitude. However, soil moisture is depleted to low values in summer when high temperatures and dry northerly winds increase evapotranspiration. Variability of precipitation is also greater in the summer but this does not exceed world variability for this mean (world figures from Leeper, 1960).

In the study area itself throughfall was measured beneath the forest and found approximately equal to the rainfall in the open at Kinglake for the same period (1962-3). Throughfall was sampled by three roving rain gauges in each of three half-acre plots set up at the ends and centre of the half mile length of the study area. No significant differences were recorded between plots during the two years of collection.

Temperatures are not extreme and the annual mean is probably 54-55°F, 4 or 5 degrees F. cooler than Melbourne. The average maximum, minimum and mean monthly figures for Melbourne are given in Table 1b. Frosts may occur in the study area during winter and spring but damage to plants in the plateau is usually restricted to potato crops and bracken in cleared areas.

* C.S.I.R.O., Division of Plant Industry, Ecology Section, Black Mountain, Canberra, A.C.T. 2414.
† Department of Botany, University of Melbourne, Victoria 3052.

TABLE 1

METEOROLOGICAL DATA

(a) *Mean monthly rainfall in inches for Kinglake (Pheasant Creek), 7 miles east of the study area on the Divide (42 year period)*

J	F	M	A	M	J	J	A	S	O	N	D	Total
3·13	2·86	3·52	4·21	4·00	4·82	4·26	4·54	4·19	4·65	3·82	3·94	47·94

(b) *Temperature data for Melbourne*

	J	F	M	A	M	J	J	A	S	O	N	D
Av. max.	77·7	78·6	74·9	67·9	62·0	56·8	56·2	58·7	63·3	67·9	71·3	75·4
Av. min.	56·9	58·0	55·2	50·8	46·9	43·8	42·6	43·7	46·0	48·7	51·8	55·3
Av. mean	67·3	68·3	65·1	59·3	54·5	50·3	49·4	51·2	54·7	58·3	61·5	65·3

TABLE 2

PARTICLE SIZE ANALYSIS

Red Soil					*Grey Soil*				
Depth Inches	% Fine Sand	% Silt	% Clay	*Texture	Depth Inches	% Fine Sand	% Silt	% Clay	*Texture
0-3	42	37	21	S.L	0-3	39	36	25	S.L
3-6	43	34	21	S.L	3-6	39	38	20	S.L
6-12	40	29	31	SCL	6-12	37	33	28	SCL
12-24	30	22	48	SC	12-24	33	34	32	SCL
24-36	30	20	53	C	24-36	31	31	35	SCL
36-48	26	18	59	C	36-48	29	48	26	SCL
48-60	26	20	56	C	48-60	32	49	23	SL
60-66	30	21	53	SC					
66-72	33	24	46	SC	60-72	21	42	41	SC

* S = Silt, C = Clay, L = Loam

The parent material of the soils in the study area is composed of weathered siltstones and mudstones. It has given rise to two kinds of gradational soil profiles usually about 6 ft deep. Both are acid, have high organic contents in the top 3 in. and a textural variation from silty loam to clay. (See Tables 2, 3 and 4).

One soil has a predominantly red profile (moist surface soil is 2·5 YR 3/6 by Munsell Colour Charts), is well structured and may be classed as a krasnozem or by the synonyms latosol or red loam. The other soil varies from dark grey (10 YR 4/1) in the surface to yellow-brown (10 YR 5/4) in the subsoil, and is not readily classified according to the Great Soil Group System. Northcote (1962) maps this soil as a yellow leached earth (Gn. 3·74) and the former as a red porous friable earth (Gn 4·14). Due to the complication of the nomenclature and classification, the soils here will be referred to as 'grey' and 'red' soils.

These soils occur as a mosaic over much of the plateau, and with either sharp or diffuse boundaries. No strong correlations between soil type and environment are immediately apparent. On the steep southern slopes of the Divide only grey soils occur and these change from gradational to duplex between the higher slopes and the foothills. On flat, intermittently waterlogged depressions on the plateau, grey gradational soils are usually found; but elsewhere on the plateau red, grey and transitional soils occur on every shade of topographic variation (Fig. 1).

The properties of these soils are similar except for their colour and iron content. Iron occurs largely as haematite in the red soil and as goethite in the grey. Other minerals in the clay fraction of both soils are similar, e.g. kaolinite, chlorite, muscovite and ilmenite (Table 5). Total phosphorus is similar in the surface soils but a rapid depletion with depth occurs in the grey soil (Table 6). In general the soils are low in

TABLE 3

pH* (means for two profiles 1: 5 suspension)

Depth in inches	*Red Soil*	*Grey Soil*
0-3	5·3	4·3
3-6	5·4	4·8
6-12	5·4	5·0
12-24	5·4	5·1
24-36	5·6	5·1
36-48	5·7	5·3
48-60	5·7	5·3
60-72	5·8	5·4

TABLE 4

Percentage organic matter (Walkley & Black titration) from two profiles

Depth	*Red Soil*	*Grey Soil*
0-3″	12·7 (14·9)*	17·6 (11·9)*
3-6″	7·1	7·2
6-12″	7·7	4·3
12-24″	3·8	2·1

* *The figures in brackets refer to the means of nine additional samples collected over this depth.*

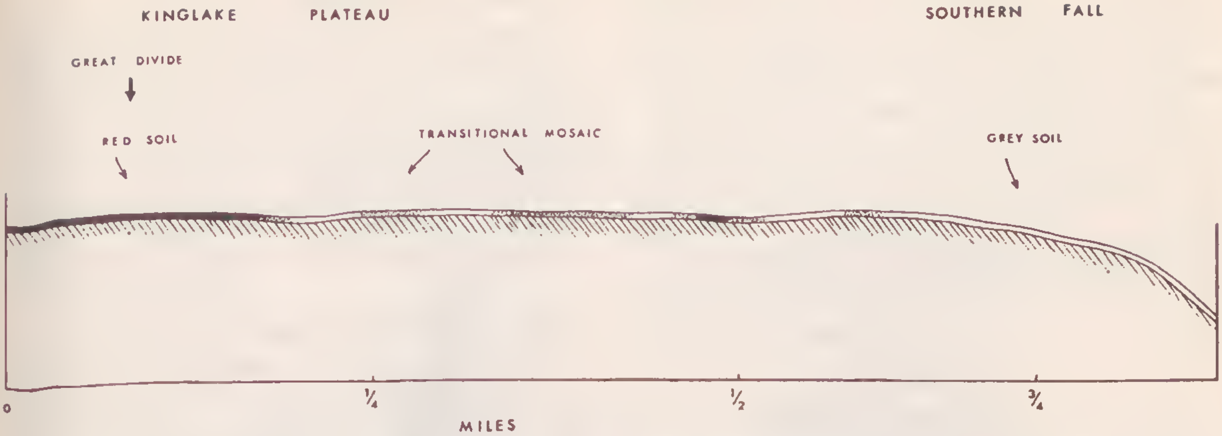

FIG. 1—Soil type distribution on the Kinglake Plateau from a North South transect line 2½ miles W. of Kinglake West. (Vertical scale = horizontal scale.)

nutrients and extremely high rates of fertilizer application at Kinglake are necessary for successful potato production (Downie, 1961). In agriculture the red soils are perhaps preferred because of their greater permeability.

TABLE 5

Clay mineralogy of Red and Grey Soils from Kinglake West (kindly determined by Dr. G. P. Briner)

Depth	*Red Soil*	*Grey Soil*
3-6″	Kaolinite	Kaolinite
	Chlorite	Chlorite
	Muscovite (trace)	Muscovite
	Haematite	Goethite
		Quartz
60-66″	Kaolinite	Kaolinite
	Ilmenite	Ilmenite (trace)
	Haematite	Goethite
	Chlorite (trace)	Muscovite

TABLE 6

Total Phosphorus in HF extract and total Iron content (kindly analysed by N. C. Uren)

	P (ppm in soil)		Fe%	
Depth in in.	*Red*	*Grey*	*Red*	*Grey*
0-3	222	200	3·9	1·3
6-12	198	128	4·3	1·9
12-24	170	120	4·6	2·4
36-48	162	115	5·0	4·3
60-72	203	93	4·4	4·1

In order to obtain an indication of the relative fertility of the two soils, seven native species from the study area were grown in pots of sieved topsoil. After five months (September to February) in the glass house the heights and dry weights of the legumes *Pultenaea muelleri*, *P. gunnii* and *Acacia verticillata* were statistically greater in the red than in the grey-soil treatment. *Leptospermum juniperinum*, a species common on soils of impeded drainage and found only on the grey soil of the study area, also grew taller on the red soil but showed no statistically significant difference in dry weight. *E. radiata* and *E. cypellocarpa* showed no treatment difference in height or dry weight, but in *E. obliqua* both of these attributes were greater on the grey soil.

Physically the soils are both very well structured with stable crumbs in the top soils and nutty sub-angular aggregates at depth. The bulk density of the red soils is lower than that of the grey soils in the surface horizons and moreover increases less steeply with depth (Fig. 2). This suggests that the red soils are better drained than the grey soils. Soil moisture at depths of 0-3″ and 12-18″, determined gravimetrically at 2-4 weekly intervals during the spring and summer of 1963 and 1964 indicated that the red soils tended to have greater amounts of available water than the grey to a depth of 18 in., and also greater moisture content at the wilting point, due to the somewhat higher clay content.

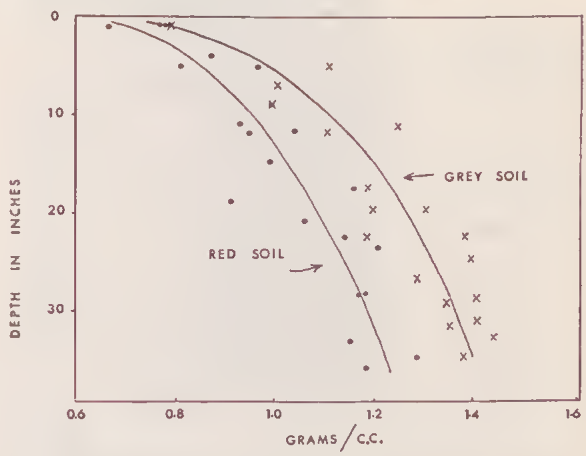

FIG. 2—Bulk density of the red and grey soils in relation to depth.

FIG. 3—Quantitative differences in floristics between soils in the study area.

The vegetation is probably under relatively low grazing pressure from the larger herbivores (wallabies, wombats, possums and rabbits). Fenced and control plots were set up in the forest in 1963. By late 1965, little difference was apparent except for increased quantities of *Poa australis, Tetrarrhena juncea* and *Haloragis tetragyna* in the fenced plots. By late 1967 the growth of all plants was greater in the fenced plots, and on both soils *Tetrarrhena juncea* was by far the most conspicuous species.

Fires have occurred in the general area in 1851, 1898, 1905, 1908, 1926 and 1938. Where fires have been severe even aged areas of *E. obliqua, E. radiata* and *E. cybellocarpa* have resulted. In many areas older generations of trees which have survived the fires are associated with a variable development of eucalypt regeneration. The undergrowth varies considerably and may be dominated by shrubs and scrambling grass or tussock grasses. The predominance of shrub species which bear fire resistant hard seeds is noticeable (*Acacia, Puletenaea* spp.).

FLORISTICS OF THE COMMUNITY

The floristics of the area was studied by recording the species present in circular plots of 20 ft radius. The plots were spaced at one chain intervals along two parallel lines one chain apart. The lines extended from the Cascades water channel for a distance of 20 chains along the edge of the plateau. Percentage cover of species was subjectively assessed in 5-10% classes (Table 7) and repeatedly checked objectively by vertical point quadrat techniques. (Twenty ft radius plots were used because the minimal area—i.e. that which contains 80% of the species, has a radius of 16 ft). The results showed that, whilst the species composition on both soils was similar, marked

TABLE 7

Cover classes used in assessments of Species

Per cent Cover	*Cover Class*
0-5	+
6-10	1
11-20	2
21-30	3
31-40	4
41-50	5
51-60	6
61-70	7
71-80	8
81-90	9
91-100	10

differences in the cover and frequency of species were evident. The major tree species on both soils were *E. obliqua* and *E. radiata*. In the study area *E. cypellocarpa* occurs chiefly on the red soil. The major qualitative differences in floristic composition is shown in Table 8, and the quantitative relationships are given in Fig. 3. The differences between the cover frequency of the vegetation components on the two soils can be better expressed if the frequency of occurrence of species above certain cover classes are considered. Thus the overall frequency of occurrence of *Pultenaea muelleri* is the same on both soils, but the frequency of it with cover values >5% is markedly greater on the red soil. Similarly, the preponderance of *Tetrarrhena juncea* on the red soil areas is greater if the cover classes from 25% to 50% are considered.

TABLE 8

Species found to be more frequent on one soil compared to the other

On Red Soil	*On Grey Soil*
	Leptospermum juniperinum
Clematis aristata	*Lindsaya linearis*
Poa australis (coarse var.)	*Drosera auriculata*
Geranium pilosum	*Dianella tasmanica*
Hydrocotyle hirta	*Hypochoeris radicata*
Tetratheca ciliata	*Lomandra* spp.
Pultenaea scabra	*Poranthera microphylla*
Spyridium parvifolium	*Epacris impressa*
Acacia verticillata	*Pultenaea gunnii*
Asterolasia asteriscophora	*Acacia mucronata*
Eucalyptus cypellocarpa	*Correa reflexa*
Pimelea axiflora	*Acacia falciformis*
	Cyathea australis

It is suggested that the greater growth of the understorey on the red soil is due to the slightly faster rate of pyric succession.

Differences in the occurrence of macrofungi also occur on the two soil types: a large number is common to both and relatively few are found only on one soil. A list of species is given in Appendices 1 and 2.

STRUCTURE OF THE COMMUNITY

(a) OVERSTOREY

The forest structure on the red and grey soils was studied by means of accurate profiles and plans in typical areas of almost flat terrain at both ends of the main transects (Fig. 4, 5, 6, 7). The canopy of the forest is fairly uneven with the major part of it between 80-120 ft. Crown depth makes up about ½–⅓ of the total height. Degenerate trees occur here and there with emergent stag-headed crowns and fluted butts bearing old fire scars. The girths of these trees at breast height reach 19′ 9″ for *E. obliqua* and 11′ 9″ for *E. radiata*. The corresponding maximum heights of these species are 140 ft and 120 ft, although some of the large-girthed trees may be broken off at heights of 20-80 ft. The main components of this stratum are mature and half grown trees of spar and pole size, with flat-topped to sub-conical

FIG. 4—Profile diagram of forest on the red soil area.

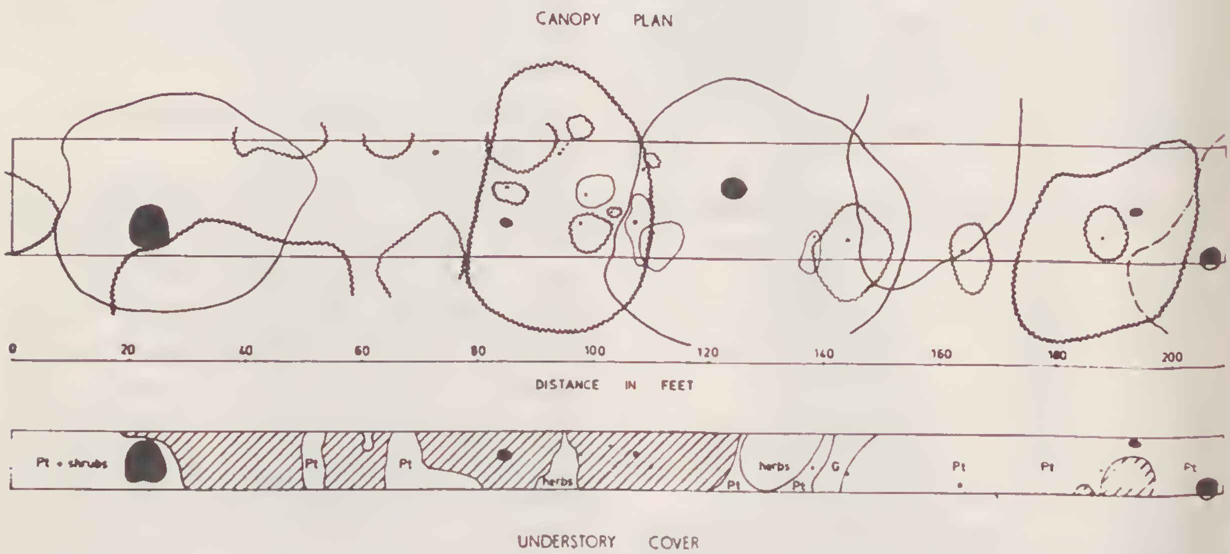

FIG. 5—Plan of forest section depicted in Fig. 4. Trees with foliage unshaded are *E. obliqua*. Trees with foliage stippled are *E. radiata*. Tree with broken outline is *E. cypellocarpa*. Hatched shading on shrub layer = *Pultenaea muelleri*.
C = *Cassinea aculeata*
G = *Goodenia ovata*
Pt is *Pteridium esculentum*

FIG. 6—Profile diagram of forest on grey soil area.

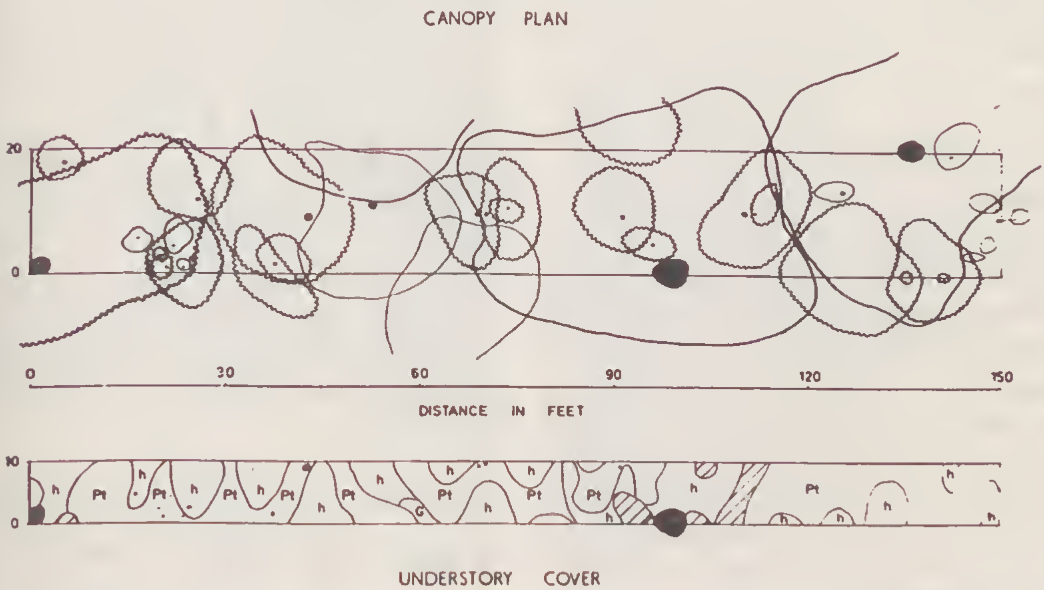

FIG. 7—Plan of forest section depicted in Fig. 6. Trees with foliage stippled are *E. radiata*. Trees with foliage unshaded are *E. obliqua*. Hatched shading on shrub layer = *Pultenaea muelleri*.
Pt = *Pteridium esculentum*   G = *Goodenia ovata*
R = small *E. radiata* plants   h = herbs

TABLE 9
Analysis of Pattern of Smaller Eucalypt Stems

Block size sq. ft	*Number of blocks*	*Mean density* m	*Density variance* V	*V/m*	*Standard error of V/m*	't'	*Significance* (Greig Smith)	(Thompson)
100	324	0·228	0·294	1·29	0·0787	3·672	P<0·001	P<0·05
400	81	0·91	1·46	1·60	0·111	5·405	P<0·001	P<0·05
900	36	2·06	3·71	1·80	0·167	4·790	P<0·001	P<0·05
3600	9	8·22	13·25	1·61	0·333	1·832	N.S.	N.S.
8100	4	18·5	25·7	1·39	0·500	<1	N.S.	N.S.

crowns. It is likely that trees of several ages occur in this stratum and that each generation has arisen following severe fires. The large-girthed trees probably exceed 100 years. Large pole-size trees 70-80 ft high bear about 40-50 rings and result from the 1926 fires.

The plan and profiles show that while overlapping of the crowns may occur, interlacing of them is absent or rare. This 'crown shyness' has been attributed by Jacobs (1955) to the sensitivity of the naked buds. In general the overall stature of the forest is somewhat greater on the red soil than the grey.

A second stratum of eucalypts is composed of trees 20-50 ft high. These trees have shallow open crowns and are oppressed or suppressed beneath the canopy of the larger trees. The patterns of distribution of the size classes of the three eucalypt species were studied on an area 120 × 270 ft in the forest on the red soil. The plot was divided into 10 × 10 ft squares and each tree or seedling growing thereon was charted. The plot data were combined in regular multiples according to the method of pattern analysis of Greig-Smith (1964). The deviation of the variance: mean ratio from unity was tested by methods of Kershaw (1964) and Thompson (1958). In both cases statistically significant aggregation of eucalypts <24 inches g.b.h. and 55 ft height, occurred in all plot sizes up to 900 square ft in area (Table 9). Beyond this size their distribution was at random. Although clumping of such plants cannot be correlated in any simple way with present gaps in the canopy, a relationship may have been evident at the time of their establishment following the bushfires of 1926. The taller and larger trees in the plot were found to be randomly distributed at all plot sizes. These trees comprise both the older age classes and the dominant individuals of the 1926 regeneration.

Throughout the area an inconspicuous stratum of eucalypts up to 5-6 ft in height may be found amongst the shrubs and bracken (*Pteridium esculentum*). These eucalypts usually bear few leaves and often show stem dieback. Many of these plants show evidence of having had several generations of shoots from the lignotubers at or below the soil surface and it is suggested that such plants arose following the 1926 bushfires and have persisted in an extreme state of suppression (Table 10). However, some small plants have been found without evidence of several shoot generations and with only 6 and 16 rings in two particular cases. Other similar plants have been found on recently-upthrown root-mounds and on rotten logs, indicating that a certain proportion of this class has arisen without the intervention of fire.

The relative species composition of the forest canopy varies with site quality and height in the stand. In general *E. obliqua* is more common than *E. radiata* in the upper parts of the forest canopy and moreover tends to be more common on the red soil than on the grey. In the second stratum (20-50 ft) *E. radiata* is much more common than *E. obliqua* on both soils. *E. cypellocarpa* is absent on the grey soils (except along drainage lines) and its presence on the red soils is sporadic in the larger classes, although somewhat more frequent in the very small suppressed classes.

Although observations of both even-aged and mixed-aged forests suggest that *E. radiata* is relatively more common than *E. obliqua* among the lower height classes than in the taller classes, a more quantitative assessment of the phenomenon was desired.

TABLE 10
Ring counts on *Eucalyptus* from the 20-35 ft substratum of the Forest

Species	*G.B.H. in ins.*	*Ring count at base*	*Years since fire*	*Year of count*
E. radiata	10	33	37	1963
,,	10	38	37	1963
,,	6	24	37	1963
,,	5	35	37	1963
,,	12	38	40	1966

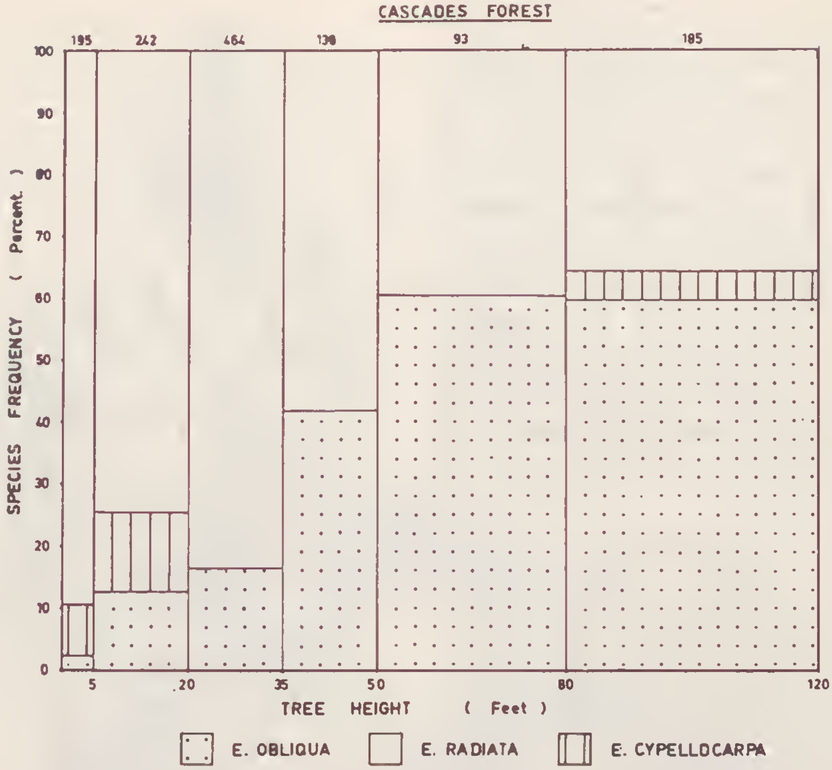

FIG. 8—Change in eucalypt-species proportions according to tree height.

The large number of girth measurements taken by plot sampling was converted to height data by regression analysis and the regression data were processed by first separating the 'sub-canopy' trees ($<$ 80 feet tall) from the 'canopy' trees ($>$ 80 feet tall). For the sub-canopy trees the regression coefficients for height on girth breast height were very high and statistically significant—i.e. 0·990 for *E. obliqua* and 0·975 for *E. radiata*. For the canopy trees the variability of height was great (due to stag-headed trees for example) but the average height varied little with a large change in girth. The overall average height for the canopy trees on the red soil was higher than for those on the grey. For purposes of comparison of species proportions within various strata of the forest the canopy trees have been considered as one broad class embracing both soils. Comparisons among sub-canopy trees are also based on combined data, as the regressions for the two species on the two soils were very similar. The comparison between species frequencies in broad height groups within the forest are shown in Fig. 9.

A further check on the change in species relationships within the forest was made by the collection of direct height data for the two species on each soil. The same relation as that predicted by observation and conversion of girth data to height data by regression, was revealed by this direct method also: the proportion of *E. radiata* plants in the lower strata of the forest is much greater than in the upper.

(b) THE UNDERSTOREY

The understorey consists of an interrupted and patchy shrub stratum of various legumes (*Acacia verticillata, A. falciformis, Pultenaea muelleri, P. scabra, P. gunnii*) 5-20 ft high, an open lower stratum of rhizomic ferns (*Pteridium, Culcita*), grasses (*Tetrarrhena, Poa*), low shrubs and herbs. The dominant shrub *Pultenaea muelleri* occurs in dense patches and thickets and is conspicuously

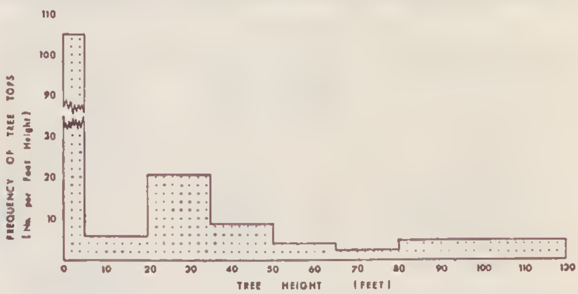

FIG. 9—Histogram of heights of eucalypts from both soil types.

taller and denser and better developed on the red soil areas than on the grey soil areas under similar canopy densities of *E. obliqua* and *E. radiata*. The patches of *P. muelleri* are frequently domed or conical in profile but may show dieback and death in the centre with the formation of hollow rings 15-20 ft in diameter. Excavations of the root systems show that the clumps expand vegetatively, although the possibility of seedling regeneration cannot be ignored. Sections of the horizontal connections between stems showed that these structures were roots and that the vegetative spread occurred by means of root suckers (Fig. 10). Ring counts at the stem bases were usually clear and showed a high correlation coefficient (0·979) with height. Such relationships were found to hold only within individual clumps: the tallest plants measured were 16 ft high and appear to be about 15 years old.

On the basis of size and vigour, clumps of *P. muelleri* can be arbitrarily classified into five stages (Table 11) depicting its advance and ultimate degeneration and death. One clump with a hollow centre was studied in detail and plan and profile diagrams were made (Fig. 11, 12). The results of this study indicate that the older stages form an annulus and that the centre is now being recolonized by young sucker plants. Many mature clumps died during the 1967 drought.

In spite of the density of the *Pultenaea* stems there appears to be relatively little correlation with the occurrence of developmental stages and the presence of other species. The main correlation that can be seen is the greater abundance of bracken *(Pteridium esculentum)* in the pioneer stages of *Pultenaea* and its scarcity in the mature phases of the shrub. Most patches have not developed the hollow centre, but this may be merely a reflection of the age of its development following the last disturbance by fire. A well developed patchy stratum of *P. muelleri* is likely to be the expression of mature understorey in this association since a repetition of it can be found in many other similar stands on the Hume Range. The pattern of stem densities of this shrub

TABLE 11

Classification of *P. muelleri* for plan diagram of a single clump

Stage	*Height (ft)*	*Vigour*
1. Pioneer	0-2	Good
2. Early building	2-3¾	,,
3. Late building	3¾-5½	,,
4. Mature	>5½	,,
5. Degenerate	>5	Dying out in numbers*

* *This was especially so in the dry summers 1965-8.*

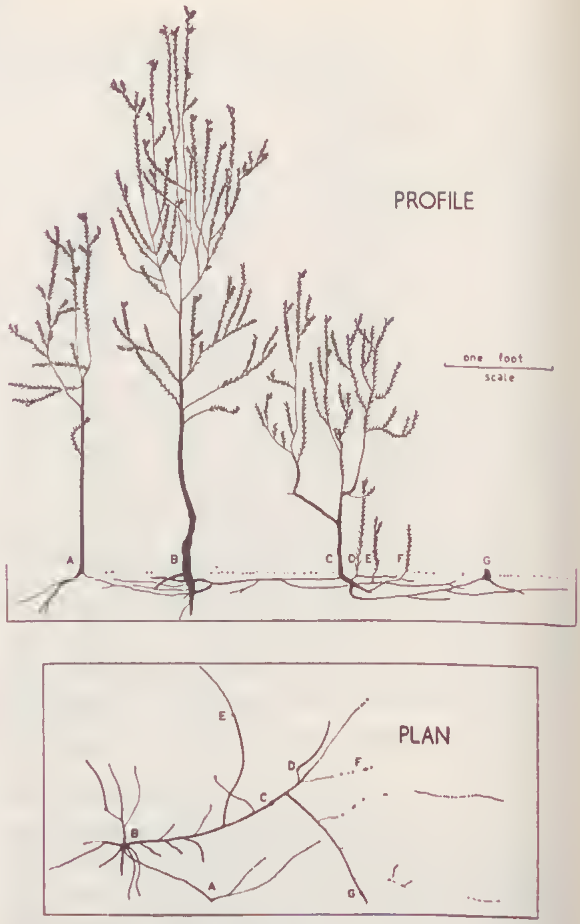

FIG. 10—Profile showing root connections between shoots.

suggest that it follows a cyclic development of continual change in time and space similar to that of other species described by Watt (1947).

(c) DISCUSSION

A number of lines of evidence suggest that the red soil area has slightly higher site quality than the grey soil area. The evidence comes from the pot experiments (where growth of native legumes was greater in the red soil in the glasshouse), from agriculture (where the red soils are favoured for potato growing), from the heights of the same aged forests on the two soils (tend to be greater on the red soil), and from the development of the understorey (*Pultenaea muelleri* shows greater development on the red soil and is a major component of the understorey). However these differences are not extreme and the different species-frequencies on the two soils in the study area may be explained by slightly greater rate of succession after fire on the red soils.

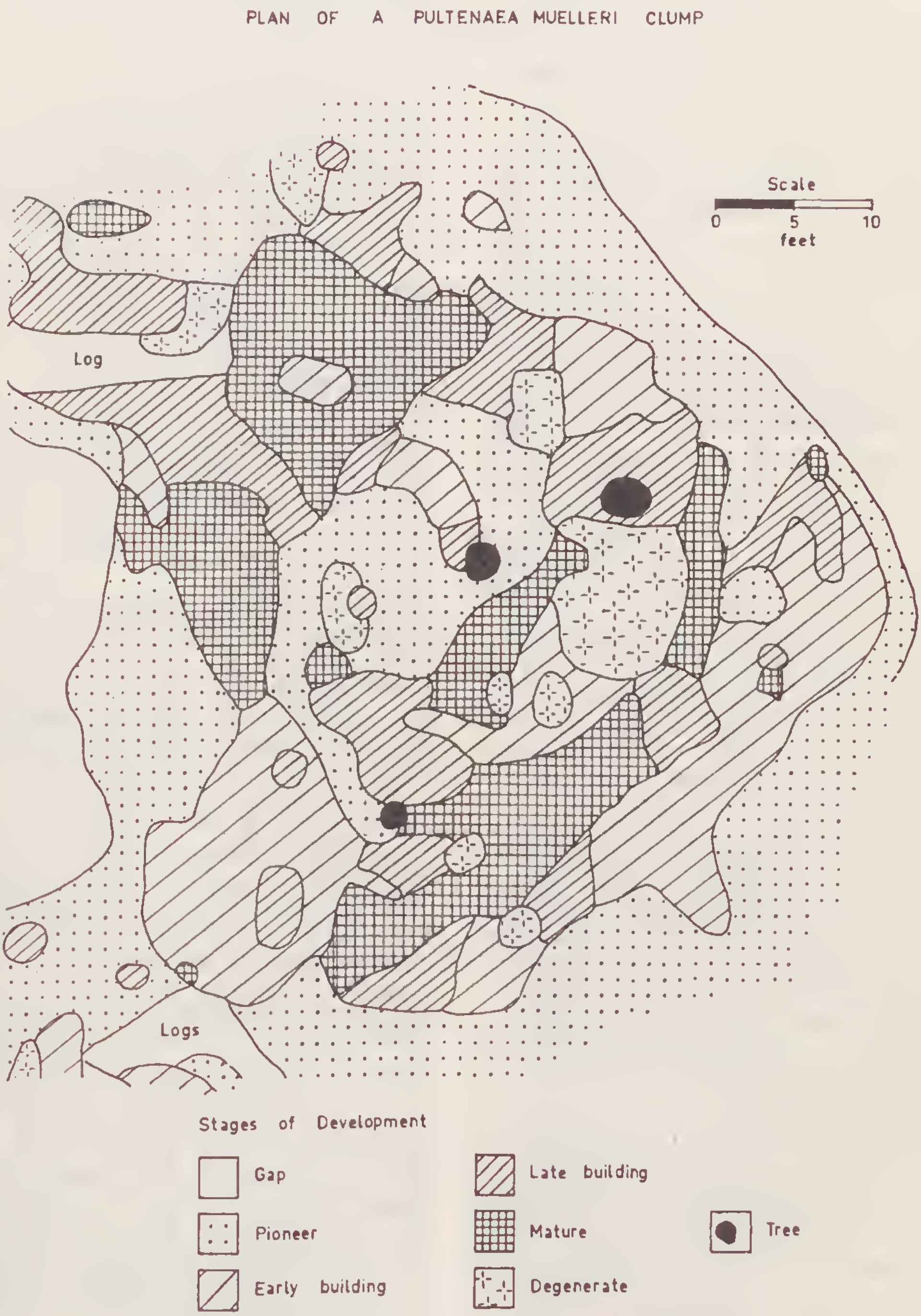

Fig. 11—Plan of a *Pultenaea muelleri* clump on red soil.

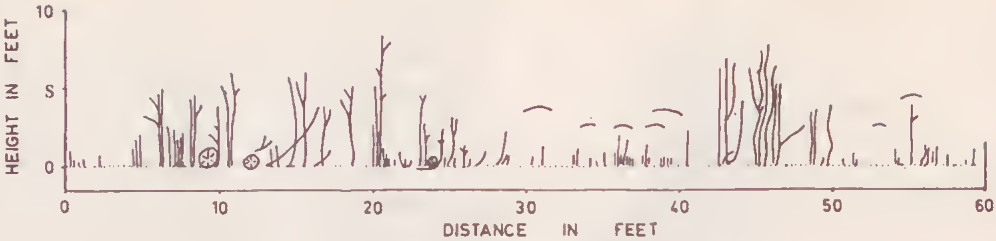

FIG. 12—Profile across widest diameter of clump in Fig. 11.

The main canopy of the forest appears to be of mixed age, as the forms and sizes of the trees are so varied in comparison to stands known to be even-aged. The even-aged forests of the area are composed of the same species as this study and arose following severe fires in the past. Ring counts on trees 20-70 ft high in the mixed-age forest in this study area suggest they arose following the last fire. The variation in ring counts is probably due to the omission of rings under suppressing conditions as has been noted by Bormann (1965), and the duplication of rings following an interruption of the growing period by drought. It is unlikely that any of these plants have arisen in the interfire period, although some of the very small stunted plants of the shortest stratum may have done so, as in the regeneration of the jarrah (*E. marginata*) forests of Western Australia (van Noort, 1960).

The reasons for the change in *E. radiata* proportion with height in the forest do not appear to be related to different susceptibilities of the two dominant eucalypt species to sub-canopy light intensities *per se* (Gill, 1966), but rather to the combination of this factor with other microclimatic and edaphic factors. Attiwill (1964) has shown that in spar stage forest of *E. obliqua* on red soil on Mt. Disappointment the deficiency of available phosphorus may be an important factor limiting the growth of eucalypt regeneration. Patterns of eucalypt stem distribution are closely related to catastrophic fires at irregular intervals. Thus the clumps of small eucalypt stems in this study may be related both to death of large stems and regeneration in gaps after fire. Canopy closure after fire may obscure any early relation between gaps and regeneration.

It is possible that the increased development of *Pultenaea muelleri* thickets, bracken and wiregrass (*Tetrarrhena*) with maturity of overstorey could result in more restricted opportunities for seedling regeneration of eucalypts. It seems likely that the greater persistence of *E. radiata* seedlings and saplings and the limited success of this species in establishment in this forest without fire could result in a greater preponderance of it in the future. It is suggested (Jacobs 1955, p. 124) that if the oppressed plants of *E. radiata* continue to persist and maintain their ability to recover from suppression, the long-term absence of fire may gradually convert the stand to *E. radiata* dominance. With the intervention of crown and ground fires the original predominance of *E. obliqua* could be restored.

CLASSIFICATION OF THE COMMUNITY

A physiognomic classification is the most accepted in Australia (Beadle & Costin, 1952; Webb, 1959; Wood & Williams, 1960; Leeper 1970). The major criteria used in such a classification are plant form, size and abundance, stratification, leaf size and texture and the presence or absence of epiphytes.

Maturity has been suggested as a prerequisite to classification (Beadle & Costin, 1952; Wood & Williams, 1960), but such a criterion may result in the interpretation of communities rather than their classification. Plant communities at all stages of maturity should be described and classified objectively and then interpreted.

The community of the present study is composed largely of trees of forest form with an understorey of short (1 to 6 ft) to tall (6 to 25 ft) shrubs with small (nanophyll) leaves.

In the study area the mixed-aged forest contains many mature and degenerate trees and small groups and patches of 40 year old pole stage trees. The last major fire in the area was that which permitted the regeneration of the pole-stage class. The study of the understoreys of the study area suggest that the *Pultenaea muelleri - Pteridium esculentum - Tetrarrhena juncea* type is a self-perpetuating stratum throughout much of this forest on both soil types. Dense even-aged pole-stage forests generally have an understorey of *Pteridium esculentum* with a meagre development of *Pultenaea muelleri* and other shrubs. It is likely that changes in the understorey will accompany changes in the density and form of the overstorey. In some red soil sites in the study area the establishment of scattered broad-leaved (notophyll) shrubs, such as *Pomaderris aspera, Olearia argophylla* and *Bedfordia salicina* has occurred. The sporadic occurrence of *Cyathea australis* in this forest is correlated with special niches such as the depressions formed by the upthrown roots of fallen trees. It is possible that with further maturation of the overstorey and a continued absence of fire, further establishment of the broad-leaved shrubs may occur. In such an eventuality this tall open-forest formation would need to be reclassified from a dry sclerophyll to a wet sclerophyll sub-form. It seems therefore that the classification of the forests of the Kinglake West area may depend on the frequency and severity of burning and the maturation of the overstorey and understorey.

ACKNOWLEDGMENTS

We would like to thank Professor J. S. Turner for the use of the facilities of the Botany Department, University of Melbourne, and the Melbourne and Metropolitan Board of Works for permission to work in the area. One of us (A.M.G.) is indebted to the University of Melbourne and the Australian Cattle and Beef Research Committee for scholarships during the course of this work.

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APPENDIX 1:

VASCULAR PLANTS OF THE STUDY AREA

PTERIDOPHYTA

CYATHEACEAE
Cyathea australis (R. Br.) Domin.
DENNSTAEDTIACEAE
Culcita dubia (R. Br.) Maxon.
Histiopteris incisa (Thunb.) J. Smith.
Pteridium esculentum (Forst.f.) Nakai.
LINDSAYACEAE
Lindsaya linearis Swartz.
BLECHNACEAE
Blechnum nudum (Labill.) Mett.

ANGIOSPERMAE

MONOCOTYLEDONAE

GRAMINAE
Danthonia penicillata (Labill.) Pal. Beav.
Deyeuxia quadriseta (Labill.) Benth.
D. rodwayi J. W. Vickery.
Microlaena stipoides (Labill.) R. Br.
Poa australis spp. agg.
Tetrarrhena juncea R. Br.
CYPERACEAE
Gahnia sieberiana Kunth.
Lepidosperma elatius Labill.
LILIACEAE
Dianella tasmanica Hook.f.
Burchardia umbellata R. Br.
Lomandra longifolia Labill.
L. filiformis (Thunb.) Britten.
Thysanotus tuberosus R. Br.
ORCHIDACEAE
Caladenia spp.
Chiloglottis gunnii Lindl.
Prasophyllum brevilabre (Lindl.) Hook.f.
Pterostylis longifolia R. Br.
Thelymitra media R. Br.
Cryptostylis leptochila F. Muell. ex. Benth.

DICOTYLEDONAE

PROTEACEAE
Lomatia ilicifolia R. Br.
RANUNCULACEAE
Ranunculus hirtus Bks. and Sol.
Clematis aristata R. Br. ex DC.
DROSERACEAE
Drosera auriculata Backh. ex Planch.
PITTOSPORACEAE
Billardiera scandens Sm.
ROSACEAE
Acaena anserinifolia (Forst. & Forst.f.) Druce.

LEGUMINOSAE
Acacia falciformis DC. now *A. obliquinervia* Tindale.
A. melanoxylon R. Br.
A. mucronata Willd. ex H. Wendl.
A. verticillata (L'Hérit.) Willd.
Daviesia ulicifolia Andr.
Pultenaea gunnii Benth.
P. scabra R. Br.
P. muelleri Benth.
GERANIACEAE
Geranium pilosum Forst.f. ex Willd. now *G. potentilloides* L'Hérit. ex D.C.
OXALIDACEAE
Oxalis corniculata L.
RUTACEAE
Asterolasia asteriscophora (F. Muell.) Druce.
Correa reflexa (Labill.) Vent.
TREMANDRACEAE
Tetratheca ciliata Lindl.
POLYGALACEAE
Comesperma volubile Labill.
EUPHORBIACEAE
Amperea xiphoclada (Sieb. ex Spreng.) Druce.
Poranthera microphylla Brongn.
STACKHOUSIACEAE
Stackhousia monogyna Labill.
RHAMNACEAE
Pomaderris aspera Sieb. ex DC.
Spyridium parvifolium (Hook.) F. Muell.
GUTTIFERAE
Hypericum japonicum Thunb.
VIOLACEAE
Viola hederacea Labill.
THYMELIACEAE
Pimelea axiflora F. Muell.
P. linifolia Sm.
MYRTACEAE
Eucalyptus cypellocarpa L. Johnson (formerly *E. goniocalyx* F. Muell.)
E. obliqua L'Hérit.
E. radiata Sieb. ex DC.
Leptospermum juniperinum Sm.
HALORAGACEAE
Haloragis tetragyna (Labill.) Hook. f.
ARALIACEAE
Astrotricha asperifolia F. Muell. ex Klatt.
UMBELLIFERAE
Hydrocotyle hirta R. Br.
Xanthosia dissecta Hook. f.
EPACRIDACEAE
Acrotriche serrulata R. Br.
Epacris impressa Labill.
GENTIANACEAE
Centaurium minus Moench.
LABIATAE
Prostanthera hirtula F. Muell.
RUBIACEAE
Asperula scoparia Hook. f.
Coprosma quadrifida (Labill.) Robinson
CAMPANULACEAE
Lobelia gibbosa Labill.
Wahlenbergia gracilis A.DC.
GOODENIACEAE
Goodenia elongata Labill.
G. ovata Sm.
STYLIDIACEAE
Stylidium graminifolium Swartz
COMPOSITAE
Bedfordia salicina (Labill.) DC.
Cassinia aculeata (Labill.) R. Br.
Gnaphalium japonicum Thunb.
Hypochoeris radicata L.
Lagenophora stipitata (Labill.) Druce
Leontodon taraxacoides (Vill.) Merat.
Olearia argophylla (Labill.) Benth.
O. phlogopappa (Lab.) DC.
O. lirata (Sims.) Hutch.
O. erubescens (Sieb. ex DC.) Dippel.
O. rugosa (F. Muell. ex Arch.) Hutch.

APPENDIX 2:

MACROFUNGI RECORDED FOR THE STUDY AREA FOREST ON THE RED AND GREY SOILS DURING 1962-1964

(*Some species recorded only for grey soil which occur on red soil in *E. regnans* forest.)

	Red Soil	Grey Soil
Aleuria aurantia	+	
Boletus multicolor	+	
B. brunneus	+	
Cortinarius austrovenetus	+	
C. albidus	+	
C. lavendula	+	
Clavaria botrytis	+	
Calostoma fusca	+	
Collybia percava	+	
Galera crispa	+	
Hebeloma mesophaeum	+	
Inocybe granulosipes	+	
Pleurotus lampas	+	
Russula erumpens	+	
R. delica	+	
Polyporus sacer	+	
Cortinarius archeri	+	+
C. castanofulvus	+	+
Clavaria sinapicolor	+	+
C. ochraceosalmonicolor	+	+
Hypholoma fasciculare	+	+
Hydnum graveolens	+	+
H. repandum	+	+
Laccaria laccata	+	+
Lactarius seriflnus	+	+
Lepiota subcristata	+	+
Mesophellia arenaria	+	+
Pleurotus viscidulus	+	+
Paxillus infundibuliformis	+	+
Russula purpureoflava	+	+
Tricholoma coarctata	+	+
T. terreum	+	+
*Amanita grisea**		+
A. ochrophylla		+
Boletus erythropus		+
*Cortinarius cinnamomeus**		+
C. subarcheri		+
C. microarcheri		+
*C. cinnibarinus**		+
C. sublargus		+
*Clavaria australiana**		+
*Collybia radicata**		+
Hysterangium neglectum		+
*Lepiota cristata**		+
Russula xeramplina		+
*R. pectinoides**		+
Rozites australiensis		+

Note: Species were determined largely from Cleland, *Fungi of South Australia*.